24

Diseases in Seed Production

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Abstract

In the U.S. Pacific Northwest, the most significant diseases affecting seed production of tall fescue [*Lolium arundinaceum* (Schreb.) Darbysh.] are fungal diseases, including stem rust, caused by *Puccinia graminis* subsp. *graminicola* Pers., and blind seed, caused by *Gloeotinia temulenta* (Prill & Delacr.) Wilson, Noble & Gray. Stem rust is an especially destructive foliar disease with potential for significant yield reductions. Blind seed is a disease of the developing seed, characterized by low seed germination. Other important fungal diseases but generally less destructive than rust or blind seed include *Fusarium* head blight, caused by *Fusarium* species; ergot, caused by *Claviceps purpurea* (Fr.:Fr.) Tul.; and leaf spotting diseases, caused by species of *Cercosporidium, Dreschlera, Rhynchosporium,* and *Septoria*. In addition, damage to seed stalks from insects or fungi can result in death and subsequent bleached or silvery-white appearance of the seed heads, a condition commonly referred to as silver top. Disease control recommendations, including registered fungicides and application rates, for specific diseases in the Pacific Northwest are available at http://plant-disease.ippc.orst.edu (verified 11 May 2009). Although many other pathogens can infect tall fescue, they have not been found to be troublesome in tall fescue seed production in the Pacific Northwest.

In the U.S. Pacific Northwest, the most significant diseases affecting seed production of tall fescue are fungal diseases, including stem rust caused by *Puccinia graminis* subsp. *graminicola,* and blind seed caused by *Gloeotinia temulenta*. Stem rust is an especially destructive foliar disease with potential for significant yield reductions. Fungicides are required for rust control. Blind seed is a disease of the developing seed, characterized by reduced seed germination. During the 1940s, blind seed caused devastating reductions in seed germination and threatened the grass seed production industry in the Willamette Valley (Hardison, 1962a).

By the late 1940s, postharvest field burning (see Chapter 18, Craig, 2009, this publication) was established as an effective control for blind seed. By the 1950s, field burning was generally accepted as a postharvest management practice for control of blind seed, other diseases, weeds, and as a means of straw residue removal. Field burning remained an important component of pest management in grass seed production in Oregon until legislation in 1991 limited acreage

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burned to 16,187 ha annually for grasses grown for seed in the Willamette Valley. Fortunately, there has not been a widespread resurgence of blind seed disease, but blind seed has caused significant reductions in germination in some fields of early maturing cultivars of tall fescue.

Other fungal diseases of tall fescue that are important but generally less destructive than rust or blind seed include *Fusarium* head blight, caused by *Fusarium* spp.; ergot, caused by *Claviceps purpurea;* and leaf spotting diseases, caused by species of *Cercosporidium, Dreschlera, Rhynchosporium,* and *Septoria.* Leaf spotting fungi are most active under cool, rainy conditions during fall and spring. In addition, damage to seed stalks from insects (see Chapter 9, Popay, 2009, this publication) or fungi can result in death and subsequent bleached or silvery-white appearance of the seed heads, a condition commonly referred to as silver top.

Disease control recommendations, including registered fungicides and application rates, for specific diseases in the Pacific Northwest are available at http://plant-disease.ippc.orst.edu (verified 11 May 2009). Although many other pathogens can infect tall fescue (Farr et al., 1989; Smith et al., 1989; Sprague, 1950) (see Chapter 8, Latch, 2009, this publication), they have not been found to be a problem in tall fescue seed production in the Pacific Northwest.

Stem Rust

Tall fescue is susceptible to infection by certain populations of *P. graminis* subsp. *graminicola* (Urban, 1967), whose host range also includes orchardgrass (*Dactylis glomerata* L.) and ryegrass (*Lolium* spp.) (Pfender, 2001a). Stem rust (Fig. 24–1, left and center) can cause severe yield losses, up to 40%, in seed crops of tall

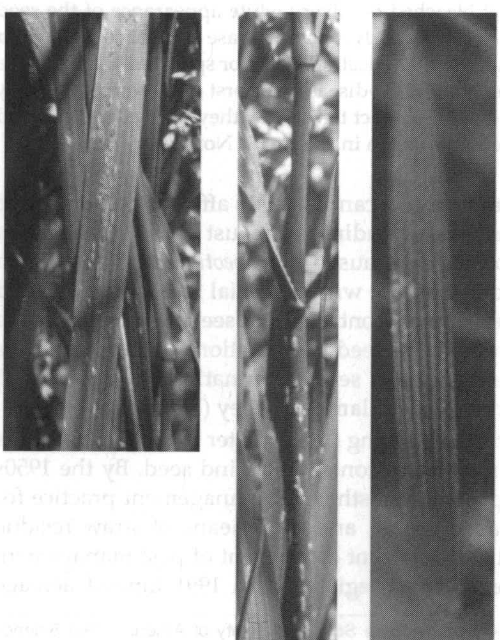

Fig. 24–1. (Left) Pustules with urediniospores of *Puccinia graminis* subsp. *graminicola* (stem rust) on tall fescue leaves; (center) stem rust pustules on leaf sheath covering stem of tall fescue; (right) uredinial pustules of stem rust on young leaf of tall fescue in early spring. See the enclosed CD for color versions of the figures in this chapter, which illustrate the disease organisms and signs better than the black and white figures in the book.

fescue. Stem rust severity and damage are generally more severe in first-year tall fescue seed fields than in older, established stands.

The pathogen produces several types of spores, but it is only the urediniospores (whose rust color gives the disease its name) that are involved in epidemics in commercial seed production. The summer epidemic begins when spores produced from overwintering infections (Fig. 24–1, right) are blown by wind to fresh leaf tissue. Infection requires several hours of leaf wetness during the night, followed by continued leaf wetness at the beginning of the morning light period. Probability of infection increases with temperatures between approximately 2 and 28°C; therefore, infection hazard is greatest when a warm, wet night is followed by a morning with persistent dew on the plants (Pfender, 2003). Infection cycles also occur more rapidly in warm than cool conditions because the latent period (amount of time between infection and the production of new spores from the infection) decreases from 69 d at 3.5°C to only 8.5 d at 26.5°C (Pfender, 2001b). The overall speed and severity of stem rust epidemics thus depend largely on spring and summer weather. Because of this strong influence of weather on epidemic onset and development, severity can differ significantly among years. Research is in progress to develop a weather-based warning system for stem rust epidemics of perennial ryegrass (*L. perenne* L.), a disease similar to that on tall fescue.

In addition to the effects of spring and summer weather on epidemic development, the amount of inoculum that successfully overwinters has a great impact on the earliness, and hence the eventual severity, of the summer epidemic. Although the overwintering biology of tall fescue stem rust has not been investigated, results of research on stem rust of perennial ryegrass indicate that significant overwintering is more likely on seedlings planted early during the preceding autumn than those planted late in the autumn (Pfender, 2004a). This suggests that disease risk can be diminished by avoiding early autumn planting.

Tall fescue cultivars vary somewhat in susceptibility to stem rust (Welty and Barker, 1993), and germplasm with a significant level of rust resistance has been identified (Barker and Welty, 1997; Barker et al., 2003). However, no current commercial cultivars grown for seed (see Chapter 23, Rolston and Young, 2009, this publication) can be produced reliably without chemical protection from stem rust. Good protection can be obtained with triazole or strobilurin fungicides, and a chlorothalonil fungicide may be combined with the first application of systemic fungicide during the season. Depending on earliness and rate of epidemic development, one to three applications may be required on seed crops during the growing season to prevent losses from stem rust (Pscheidt and Ocamb, 2001). Studies on stem rust of perennial ryegrass show that a major proportion of the damage from this disease occurs when infections spread from the leaf sheath to the enclosed inflorescence as it emerges from within the sheath (Pfender, 2004b). Control of this secondary disease spread to the inflorescence is critical for disease management, and the different fungicides are differentially effective in achieving this result (Pfender, 2006). Although fungicide activity against tall fescue stem rust is similar to that against perennial ryegrass stem rust, the strobilurin fungicides have a longer time window of effectiveness against this internal disease spread than do the triazoles. To preserve the long-term usefulness of strobilurin fungicides, however, it is essential to guard against development of fungicide resistance in the pathogen, by rotating or tank-mixing the strobilurin with triazole fungicides.

Blind Seed

Blind seed, caused by *Gloeotinia temulenta*, is characterized by reduced seed germination. The fungus colonizes the endosperm, replacing much of the endosperm tissue with a fungal mycelium. Infected seeds are shrunken and pinkish to rusty in color. However, visual detection of infected seed is difficult because grass seeds are typically covered by two glumes—the lemma and the palea—that remain uninfected and appear similar to those of healthy seeds. Infected seeds typically do not germinate, hence the name "blind seed." *Gloeotinia temulenta* survives and overwinters in infected seed. Infected seeds typically are lightweight, and precleaning seed during combining can return much of the lightweight seed fraction (including infected seed) to the field. The more infected seeds left in the field following harvest, the greater the potential for blind seed development the following spring.

In the spring, about the time of flowering in grasses, apothecia are produced from the infected seed (Fig. 24–2, left). Apothecia produce and release ascospores under moist or rainy conditions. Ascospores are easily dispersed by air currents. Only those ascospores that land on the grass flower will have the potential to infect grass ovaries and developing seeds. No other part of the plant is susceptible to infection by *G. temulenta*. The fungus proliferates within the endosperm. Within several days after infection of the developing seeds, *G. temulenta* begins to produce conidia. Within about 7 to 10 d after infection, large numbers of conidia, embedded in a pinkish colored slime layer, appear on the surface of infected seed. Under dry conditions the slime becomes hard or crusty. Under rainy conditions the slime quickly dissolves, with rain splashing as the primary means of secondary spread of the pathogen.

Detection of *G. temulenta* includes soaking the seed in an equal volume of water for about 15 min and examining the effluent at about 200× magnification for the allantoid, biguttulate conidia typical of *G. temulenta* (Fig. 24–2, right).

Gloeotinia temulenta has a wide host range (56 species of grasses), including tall fescue (Alderman, 1991; Hardison, 1962b). Control of blind seed is achieved through seed treatments (Rolston and Falloon, 1998), systemic fungicides (Hardison, 1970, 1972; McGee, 1971), and maintaining optimal soil fertility (Hampton and Scott, 1980a, 1980b). Although good blind seed control generally is obtained, blind seed can be a problem in cool, wet seasons. A comprehensive review of blind seed disease is given by Alderman (2001).

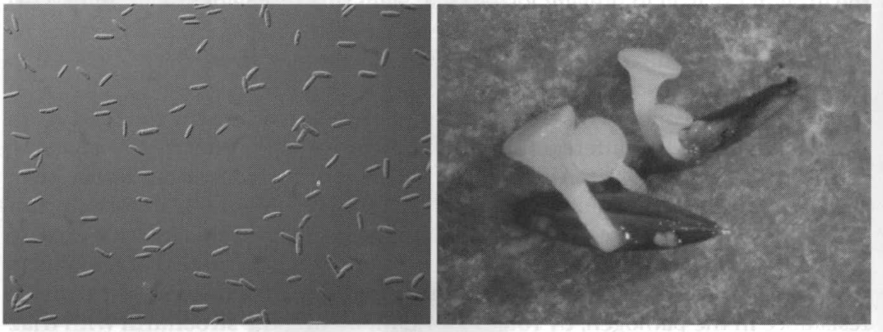

Fig. 24–2. (Left) Apothecia and (right) conidia of *Gloeotinia temulenta*.

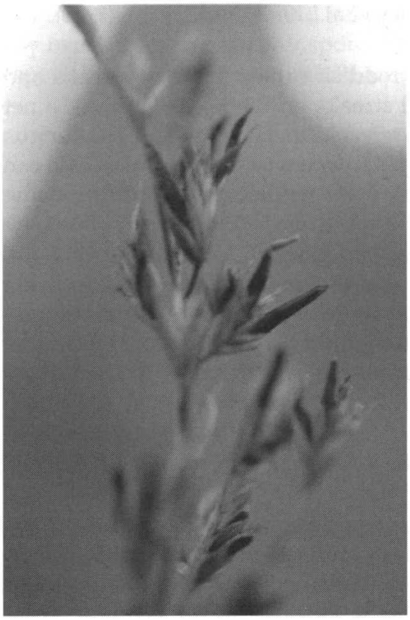

Fig. 24–3. *Lolium* spp. with sclerotia of *Claviceps purpurea*.

Ergot

Ergot is caused by the flower-infecting fungus *Claviceps purpurea*. The disease is characterized by elongated, hard, black sclerotia that extend beyond the lemma and palea in infected seeds (Fig. 24–3). Each infected seed is replaced by a single sclerotium. The sclerotium is the overwintering structure for *C. purpurea*. In the spring, about the time of flowering in the grasses, spherical, stalked fruiting bodies emerge from the sclerotia. Wet, rainy conditions favor sclerotial germination and release of ascospores. The ovary is the only plant part infected.

Within a week of infection, conidia are produced in large numbers. Conidia, combined with plant sap, can ooze from infected flowers in what is commonly referred to as the honeydew stage. The honeydew stage is followed by development and maturation of sclerotia. Maturity of the sclerotia coincides with maturation of healthy seed. The host range for *C. purpurea* includes 300 to 400 grass species, including the cereal grains and grasses for forage and turf (see Chapter 26, Samples et al., 2009, this publication). Normally, ergot is not a serious problem in tall fescue seed production. The literature on ergot is extensive, and several comprehensive reviews are available (Barger, 1931; Bove, 1970; Kren and Cvak, 1999).

Leaf Spot Diseases

All of the leaf spot diseases are favored by prolonged cool and wet conditions. The effect of leaf spot diseases on seed yields in tall fescue is not established, but in most years they likely do not contribute to significant reductions in yield. The diseases can be controlled by fungicides. Sources of additional information on leaf spot diseases of tall fescue include Smiley et al. (1993), Smith et al. (1989), and Sprague (1950).

Dreschlera and *Bipolariz* species cause reddish brown spots or streaks and leaf die-back. Longitudinal and horizontal streaks on the leaves produce a net-like appearance. The disease is commonly referred to as net blotch. The fungus survives as conidia and as dormant mycelia in infected tissue. *Dreschlera* also can cause crown or root diseases, although these have not been reported as causing problems in tall fescue seed production.

Rhynchosporium spp. cause leaf spotting, leaf die-back, or scald. Conidia are produced during cool, wet conditions and are disseminated by wind and rain splashing to healthy leaves. *Rhynchosporium* spores germinate and directly penetrate the leaf surface. The fungus proliferates within the leaf tissue and produces conidia on the leaf surface above lesions (Fernandez and Welty, 1991). The fungus survives as dormant mycelia in living or dead plant tissue.

Septoria causes grayish leaf spots. Conidia are produced in pycnidia, which appear as tiny black dots in the center of the lesions. *Septoria* survive as mycelia or pycnidia in infected tissue.

Cercosporidium graminis (Fuckel) Deighton is a common, widespread fungus with a host range that includes all cool-season turf and forage grasses. It is a common disease in the spring in the Willamette Valley on grasses grown for seed. Symptoms include elongated, brown to gray lesions. *Cercosporidium graminis* is favored by conditions that are cooler and wetter than normal (Welty, 1991).

Fusarium Head Blights

Fusarium head blight is not a common disease in tall fescue. When present, it is characterized by bright orange-colored sporodochia on panicles and seeds. The fungi, *Fusarium heterosporum* Nees:Fr. (Foudin and Calvert, 1982; Schoen and Hurst, 1986) and *F. culmorum* (W.G. Smith) Saccardo (Holms, 1983), cause head blight. The sporodochia of *F. heterosporum* have been observed during seed testing and may be responsible for reduced seed germination observed during germination tests (Schoen and Hurst, 1986). Predominant *Fusarium* spp. isolated from tall fescue seeds produced in Oregon include *F. avenaceum* (Corda: Fr.) Saccardo, *F. culmorum*, *F. pseudograminearum* O'Donnell & T. Aoki, and *F. sambucinum* Fuckel, and inoculations of tall fescue panicles with *F. avenaceum* and *F. pseudograminearum* significantly lowered germination rates of the harvested seed crop (Ocamb and Alderman, 2004). Seed can be infected without visible sporodochia. Seed decay and damping-off may be apparent in the field, characterized by poor stand establishment.

All species of *Fusarium* produce macroconidia and many species, including *F. culmorum*, *F. pseudograminearum*, and *F. sambucinum*, produce chlamydospores. Macroconidia are sickle-shaped spores, generally 3- to 5-septate, with characteristic spore shape and size on carnation leaf agar. Chlamydospores are thick-walled spores that can survive in soil for many years. Many *Fusarium* spp. also produce ascospores, and sometimes perithecia can be found on plant debris, such as stems of grass seed plants.

These *Fusarium* species are distributed widely and cause disease on many species of grasses and cereals (Smiley et al., 1993). Mycelium of *Fusarium* spp. can colonize leaf or below-ground tissues, as well as plant debris. *Fusarium* spp. generally overwinter as chlamydospores or mycelia. Conidia are produced on mycelia, especially when colonized debris are remoistened by rain, heavy dew, or fog.

Silver Top

Silver top is named for the whitish seed heads resulting from damage to the seed stalk after panicle emergence but before seed development. Affected seed heads die and bleach white, appearing to mature early. Stems of affected heads can be pulled out of the leaf sheath easily if stem-boring insects are involved. Affected heads do not set seed, and the rest of the plant appears healthy. Causes of silver top include insects or fungi that damage the seed stalk (Smith et al., 1989), thereby cutting off the supply of water and nutrients. In addition, environmental conditions such as late spring frosts or nutrient deficiencies or excesses can also cause silver top (Smith et al., 1989).

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